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A case study of educational game design *by* kids and *for* kids

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Abstract

The purpose of this case study was to explore how children designed computer games as artifacts that reflected their understanding of nutrition. In order to accomplish this goal, we asked students to design educational games that would teach first graders about nutrition. The characteristics of the games, design strategies, and collaboration among students were examined. Results from three separate student cases are presented.

Keywords; Learning by design; game design; nutrition education; Constructionism.

1. Introduction

The prevalence of commercial games that are directed toward young, elementary-aged children has risen in recent years. These include web-based games like *Webkinz World* that extend the play space for purchased animal toys to a virtual space or portable game platforms such as the *Nintendo DS.* Given the prominence of such entertainment games for young children, interest has been correspondingly generated in the educational potential of computer games for classroom use (Dickey, 2005; Kafai, 2006). The serious games movement in higher education is one indication of the extent of this interest. The implementation of computer games into elementary education, however, is a more nascent area of research and practice in education (Warren, Dondlinger, & Barab, 2008).

As such, educational theory around the use of computer games is still being developed. But, two different lines of inquiry seem to have emerged. The first concentrates on the design and effects of educational games on learning or motivation. Such research might involve incorporation of simulations, repurposing of off-the-shelf computer games, or design of computer games to meet specific curricular goals (Warren et al., 2008). Most commercially-developed educational games would fall into this category. Educational games like *Math Blaster* or *Reader Rabbit* allow for repeated drill and practice with nearly immediate feedback. In these types of games, facts are practiced over and over (e.g., addition and subtraction), but often in the context of an imaginary world, narrative, plot, or goal. Lee et al (2004) (cited in Warren at al., 2008) found in their study that this type of game design (i.e., drill and practice) supported children to practice more math facts problems, increasing both their speed and accuracy.

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A second area of research on educational gaming centers on teaching children how to design or program serious computer games for the purpose of learning more about a specific topic in the curriculum (Kafai, 2006). The notion of "learning by construction" emphasizes constructing artifacts by programming computers or designing games (Kafai, 1996). Our research follows the latter approach and builds off the work of Papert and others (Harel & Papert, 1991; Kafai, 1996; 2006) to investigate the educational impact of children programming their own computer games. The objective of this paper is to present some preliminary data on how elementary school children designed computer games that reflected their understanding of health and nutrition. In order to accomplish this goal, we asked students to design educational games that would teach first graders about nutrition. The game design software *Game Maker* (Overmars, 2004) was used as the development platform.

2. Background

The constructionist perspective puts game design in the hands of children to encourage knowledge-in-use through developing physical or digital objects (Papert, 1995). In the 1980's, this idea was initially explored by asking young children to use Papert's LOGO environment to design math games about fractions to teach to younger children about them (Harel & Papert, 1991). Constructing artifacts by programming software presumably helps students reformulate their understanding and express their personal ideas and feelings about not only the subject but also the artifact (Kafai, 2006; Papert, 1980).

Despite the interest in incorporating game construction by children into classrooms, it is relatively unexplored. Several obstacles to widespread implementation exist, such as classroom time, importance of external assessments and reporting requirements, and teacher comfort level with both game programming and constructionist teaching methods. However, some technological developments are making game programming by children more accessible (Resnick, 2007). In essence, users with no programming experience can build realistic computer games, yet few formal studies involving children have been done. Our research investigated how students used *GameMaker* to explore health and nutrition concepts in their fifth-grade science class.

3. The Project and Study Context

Our research explored the strategies and the computer games designed by 3 children in a 5th grade elementary classroom. Erin, Tom, and Sammy participated in the game design project as part of their science class during a unit on nutrition. A small class of 10 participants designed the games, but our research followed the work of three students in order to explore their processes, games, and experiences in more detail. These three students were selected based on diversity of gender and game design experience, as well as completeness of data, in order to capture a range of potential experiences with the game design task.

For this project, the students met for 45-minute sessions twice a week for 8 weeks. The class was first taught how to use *GameMaker* software. Since most students were new to the software, they were first presented with some design examples and challenges in *GameMaker*. The project promoted collaboration among students in game design. Similar to previous studies (Kolodner et al., 2003; Harel & Papert, 1991; Hmelo et al., 2000), students were encouraged to look at the other games to not only give feedback but also get ideas for their own designs. Since it was a small class, the students would typically ask the entire class for guidance on how to perform certain programming tasks. That collaboration was informal, in that students could ask for help at any time during the sessions.

At the end of the project, 16 first graders from the same school played all the games and provided feedback to 5th-grade game designers**.** During this testing process the students were observed and interviewed about the games and what they learned about nutrition from game play. After that, we also had in depth interviews with the 5th graders on an individual basis.

The research used a case study as the research methodology (Yin, 2002). A primary data source for this study was the participants' computer games. The students' games were saved separately by sessions, so multiple iterations of the games at various stages of development were examined. The following data sources were collected and used in the interpretation of results: (a) students' written goals for their game design: (b) interviews with the participants following the game design; (c) the participants' games; and (d) classroom observations. The lead author was present for all sessions. All interviews with participants were transcribed and later analyzed.

4. Findings

The results are organized around each case (student), focusing on the following: (a) background on each case/student; (b) characteristics of the students' games (game genre; game world; game characters); (c) programming and design strategies; and (d) role of peer feedback and collaboration on the design. Where apparent, gender differences will be highlighted

4.1. Erin

Erin was not interested in technological education as much as she was interested in other subjects. She rarely played games prior to the project. During the first class of the project, she asked if she could complete the task with PowerPoint software, since she was familiar and confident with it. The technology teacher encouraged her to start with designing sprites, or game characters. The simple process of sprite design in *GameMaker* was a motivating entry point for her to add actions to these sprites. After seeing her classmates' games, she began asking how to add other features to her game too.

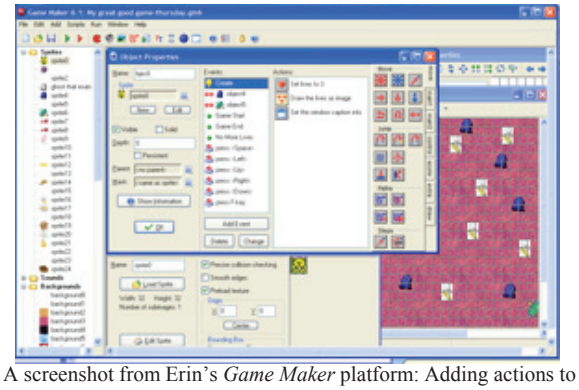

Figure 1: A screenshot from Erin's *Game Maker* platform: Adding actions to the character

Erin's game took place in an imaginary setting where the players could move in four directions. She added music to the background of her game. The goal of her main character was to eat "healthy foods" and stay away from "unhealthy foods". Similar to other commercial games, such as *Pacman*, the players' goal in her game was to keep the main characters alive to finish the game. The game would end if the game character lost life or a certain number of points. Erin's game had interaction and feedback for the players. The game started with a introduction of the task. She also used feedback when the game over. On the top bar of the game window, her game provided instant feedback with scores for each healthy food item collected and live counting for each unhealthy food taken.

As mentioned previously and consistent with research on gender and gaming, Erin expressed that she was not interested in gaming, prior to the project. However, Erin's engagement in the design process changed as she progressed through the project, as evidenced by the fact that she continued designing computer games six months after the project ended. Erin's game character doesn't represent any specific gender. When we asked why she chose the teddy bear as her main character, she said that teddy bear was "cute".

Collaboration was a key component of Erin's design process. She learned programming in *GameMaker* by asking students in the classroom. Collaboration among the students was not limited to the game design process. The students also asked questions to each other about the nutrition content of the game. For instance, we observed some students asking Erin if she had proper portion sizes of certain foods in her game. Another method of collaboration during the design project was peer testing. For example, Erin said: "*During class, they were like, 'Erin'! 'You wanna come and see? Do you like this?' and things like that…*" Testing each other's games helped students provide peer feedback and to build new features into their games, as a result of being exposed to new ideas.

4.2. Tom

Tom was a student who enjoyed computers and frequently wanted to work on them. He had his own computer at home and played games every day after finishing his homework. He was a high achieving student. Even without

knowing the task, Tom was excited when we introduced the science class to the game design project. After we showed a sample game structure, he started to ask how to make sprites and how to add actions to that sprite.

Different from the other students in the class, Tom had his own plan of the game from the first day of the project and his final version of the game was based on that plan. He, however, added some new features to his game after learning from his peers. Tom's game took place in an imaginary world. The game player has to get "healthy foods" from the maze and escape from "unhealthy foods", which were brownies and cookies to get the next level.

Different from Erin's game design, Tom did not add any scoring or text feedback for the game players. However, during each level, if the player touched one of the "unhealthy foods", then the player has to replay that level. Parallel to Kafai's findings (1996), Tom's game might not be considered violent, but it did include shooting actions to destroy the enemies, "unhealthy foods", and that might be an influence from the games he played at home.

Tom interestingly chose a "sandwich" for his main character of the game. When we asked why he chose this, he replied, "I thought it was fun". However, after the first graders tested his game, he told us that, given more time, he would change this main character to something else because the first graders were confused. Based on the first graders feedback, he decided to add a more healthy food character that represented a variety of food available to kids in real life.

4.2.1. Sammy

Playing computer games was Sammy's favorite activity at home. On his home computer, there are many multi-user games installed, and he plays them every day online. He usually prefers to work individually in his other classes. Sammy's game genre was racing, and his game was designed for the player to take the healthy foods and stay away from unhealthy foods. Since the game was modified from a racing game, unhealthy foods would show up on the player's way, or the unhealthy food would chase the player like traffic police.

As part of his game design strategy, Sammy used *modding* which offers a number of advantages over designing games from scratch (Emmerson, 2004; Seif El-Nasr & Smith, 2006). In his design, Sammy modified not only the game characters but also the scoring of his game based on nutrition concepts. For example, Sammy changed from the police car in the original game to cookies in his nutrition game. When we asked why he used cookies, he responded that cookies in daily life are too attractive for kids, and it is always hard to stay away from them. And in his game, these cookies chased the player, and once the cookies caught the player, the game ended.

Keeping with the original game, Sammy included instructions on how to play the game. A scoring bar and live counting also stayed on his game, since he thought that would be necessary for the nutrition game as well. Over time, the player might lose power and would need to get some healthy foods to power up. Based on feedback from the first graders' testing, Sammy indicated he wanted to add a feature whereby the player would lose power when it also took too much healthy food.

Game design helped Sammy improve his communication skills to collaborate with his classmates. Even though Sammy had played computer games prior to the project, this was his first experience using game design software. We observed that most of the actions and icon design he included in his game were done after asking classmates and testing others' games. He communicated frequently during class and asked questions to the teachers about his design.

5. Conclusion and Implications

This study investigated how children designed computer games as artifacts that reflected their understanding of nutrition. Similar to previous studies, our study showed that students become active participants and problem solvers by designing their own games. They also engaged in social interaction by sharing their designs, helping each other (Kafai 2005), and taking ownership of their own learning. As Reiber (1998, p. 6) states, "*Children can become deeply invested in their learning when they feel empowered to choose what they learn and the ways in which they learn*".

Although our project did not formally assess students' nutrition knowledge, we nonetheless saw evidence of application of nutrition concepts in students' game designs. It was observed that Erin, Tom, and Sammy applied a basic nutrition concept of "fruits and vegetables are healthy but too many desserts are unhealthy" in their game design. They also tried to apply the concept of 'portion size' (eating adequate amount of each food group based on the Food Pyramid) to their game in various ways. However, based on our interviews, students could not add 'portion

size' feature to their games as good as they planned prior to game design because of their limited time and technical skills.

The results of our study may provide some insights into the process used by students to develop computer games for educational purposes. Some implications of these findings for educational practice include the following:

- Designing educational games allows students to represent their understanding in concrete and personally meaningful ways.
- The students learned to ask for and provide help.
- Designing games might encourage diversity of ideas in a classroom community.
- Designing games can lead to meaningful engagement of participants and enhanced sense of classroom community.
- Game design can be highly motivating to students, as evidenced by sustained engagement.
- Learning through design can reflect integrative, authentic, and long-term curriculum units in target subjects.
- Scaffolding occurs throughout the design process by not only teachers but also peers.

Our project also revealed another important aspect of gaming research that warrants further investigation. The girls in our project designed computer games, as opposed to just playing games. Like other participants, Erin, for instance, was able to design a game that first graders learned from and enjoyed. She also continued designing computer games six months after the project ended, even though she stated that she did not regularly play computer games before the project. In the end, the girls' games were as educational and sophisticated as the boys' games.

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